Fall Creek Watershed Assessment and Total Maximum Daily Load

Final

Department of Environmental Quality

October 2003

Fall Creek Watershed Assessment and Total Maximum Daily Load

Appendix A. Beneficial Use Reconaissance Program Data

Figure 11 gives the locations of the BURP data collected in Fall Creek watershed in the years 1993, 1996, and 2001.

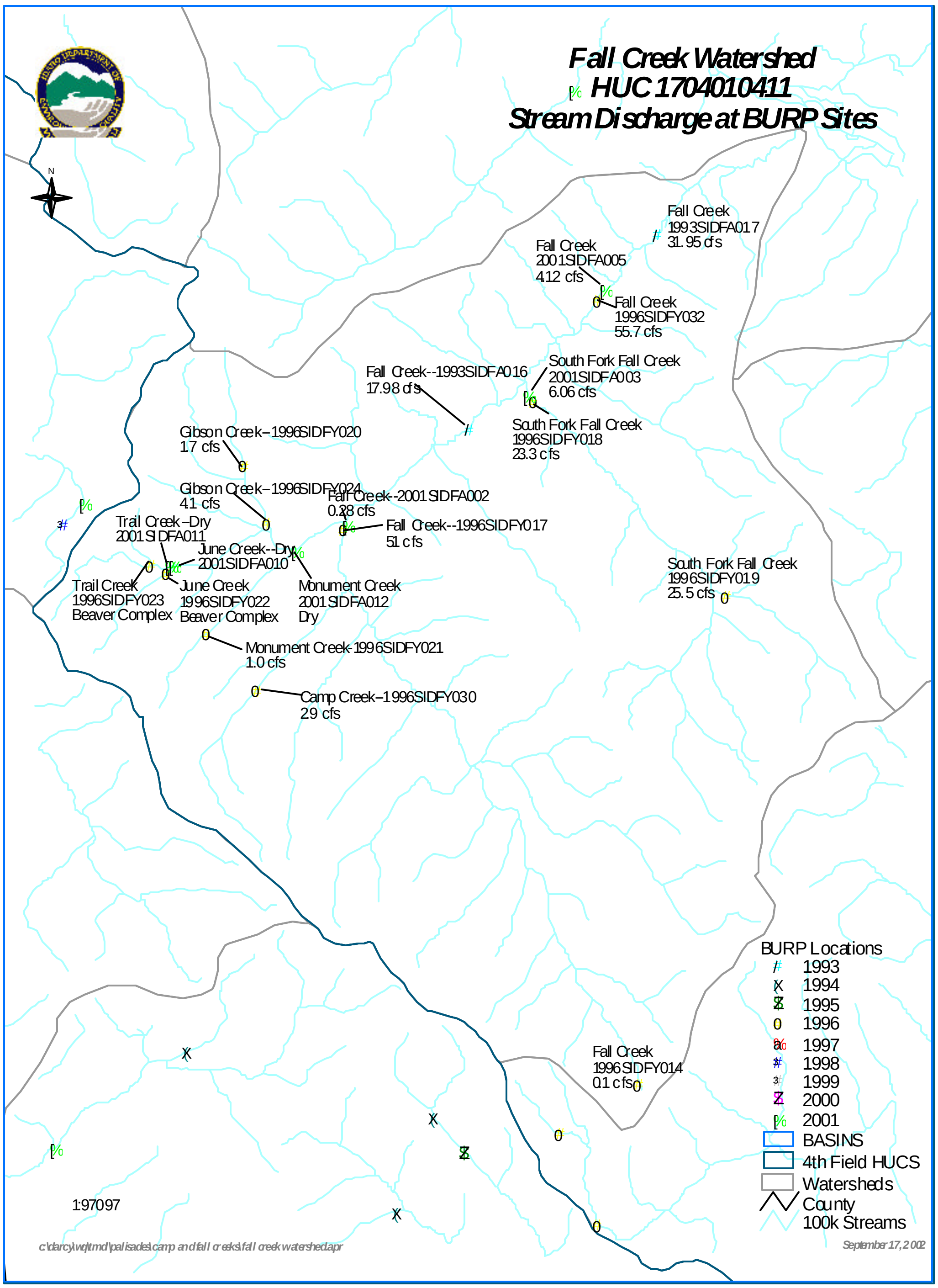


Figure 11. BURP Locations

Table 13 represents the macroinvertebrate data resulting from BURP collections made during the 1996 field season. This report is excerpted from the tables in Appendix B of the biotic integrity report (Clark 2000).

Table 13. Macroinvertebrate data analysis for Camp Creek and Fall Creek.

	Camp Creek 1996SIDFY030 30 m above crossing	**Fall Creek** 1996SIDFY014 300 m below Basin trail	**Fall Creek** 1996SIDY017 300 m above Monument Creek	**Fall Creek** 1996SIDFY032 0.5 mi above Currant Hollow
Macroinvertebrate biotic index	1.89	2.11	3.39	5.30
Percent fine surface sediment	61	60	53	36
Number cold water taxa	1	2	1	3
Percent cold water taxa	72.83	8.52	1.65	6.56
Taxa richness	16	14	16	26
Total abundance	644	528	182	244
Habitat biotic index	4.36	5.23	1.59	2.31
Shannon's H' diversity index	0.41	0.64	0.73	1.17
Percent scrapers	00.31	13.26	19.78	31.56
Percent EPT[1]	6.37	0.38	31.32	74.18
Sum EPT taxa	4	1	9	17
Percent Ephemeroptera	4.19	0	22.53	53.69
Percent Plecoptera	0.31	0	4.95	9.02
Percent Trichoptera	1.86	0.38	3.85	11.48
Number Plecoptera taxa	2	0	2	3

[1]EPT = Ephemeroptera, Plecoptera, Trichoptera

Appendix B. Streambank Erosion Inventory Results

Figure 12 presents the location of the streambank erosion inventories performed by DEQ in 2002. The remainder of Appendix B presents a summary of the results, the data analysis for each inventory, the raw data, and the results of two McNeil sediment core samples.

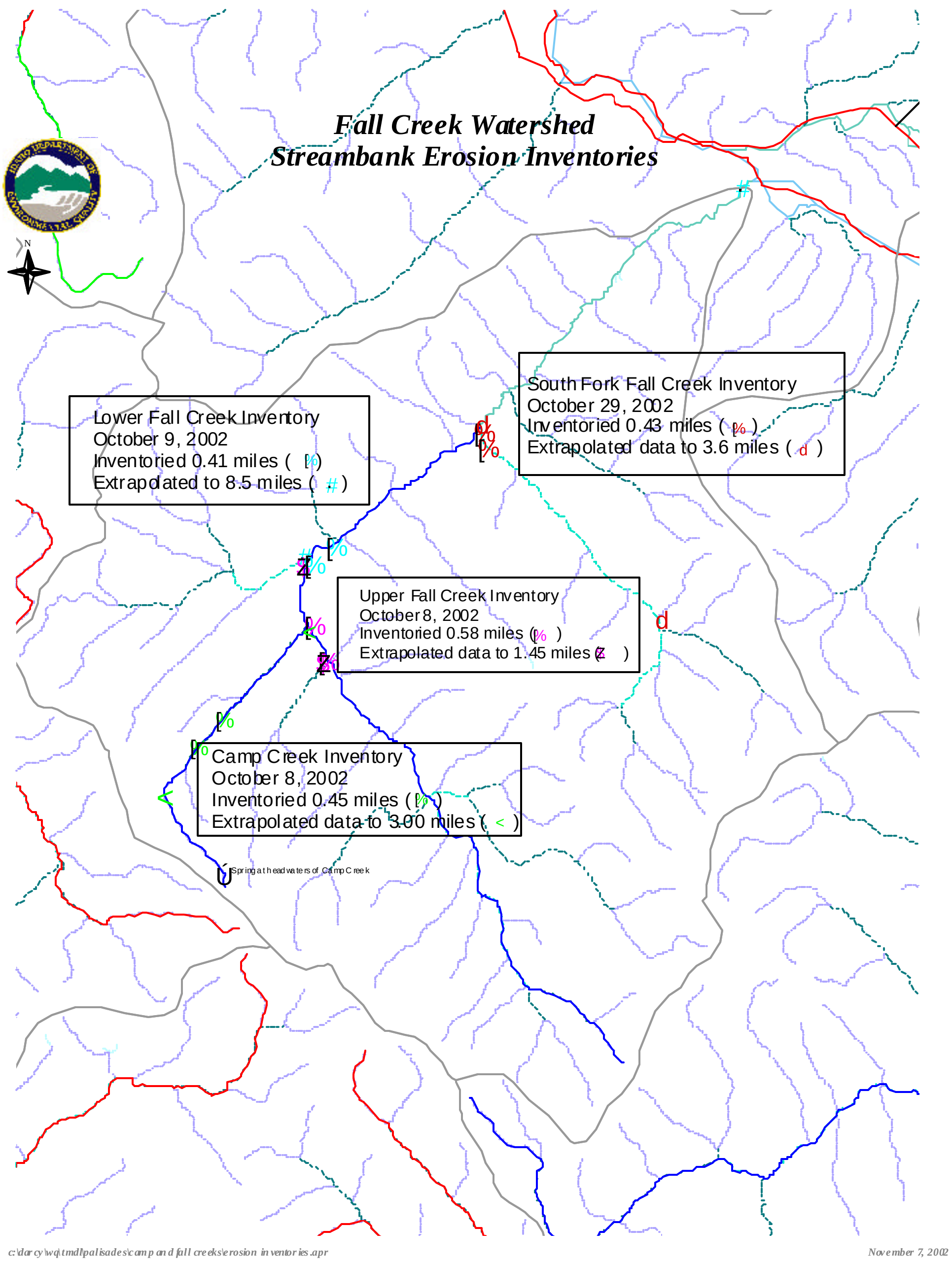


Figure 12. Streambank Erosion Inventory Locations

Streambank Erosion Inventory Results

Fall Creek Watershed Bank Erosion Load Reductions						
Reach	**Existing**		**Proposed**			
	Erosion Rate (t/mi/y)	**Total Erosion (t/y)**	**Erosion Rate (t/mi/y)**	**Total Erosion (t/y)**	**Erosion Rate Percent Reduction**	**Percent of total**
Camp Creek	189.0	634.0	10.0	31.9	**95**	78
Upper Fall Creek	65.0	133.00	11.0	23.2	**83**	16
Lower Fall Creek	3.0	27.00	9.0	80.40	**-200**	3.34
South Fork Fall Creek	4.2	15.00	9.0	30.20	**-114**	1.85
	Total Erosion (t/y)	809.0				

Depth Fines	
Fall Creek	39%
South Fork Fall Creek	40%

Stream Bank Erosion Inventory Worksheet

Stream	Camp Creek
Section	1/2 mile upstream from Forest Route 376 — **Data reduced by** Darcy Sharp
Field Crew	Tom Herron DEQ; Sr. Water Quality Analyst Melissa Thompson DEQ; Sr. Water Quality Analyst Darcy Sharp, DEQ; Biologist
Land Use	rangeland, recreation

Stream Segment Location

			Degrees	Minutes	Elevation
GPS:	Upstream	N	43	20.103	
		W	111	31.592	
	Downstream	N	43	20.458	6183
		W	111	31.156	

Stream Bank Erosion Calculations

AVE. Bank Height:	2.0	feet	Bank to bank length	**4717.8**	feet
bank to bank Eroding Seg. Length	3471.2	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.74				
Bank erosion over sampled reach (E)	84	tons/year/sample reach			
Erosion Rate (ER)	189	tons/mile/year			
Feet of Similar Stream Type	15365	feet			
Eroding bank extrapolation	26081.31	feet			
Total stream bank erosion	**634**	tons/year			

Comments

Flow a contributing factor?: Yes

Because of bare bank and highly incised channel

Other contributing factors?: Heavily trampled from grazing; bank chiseling.

Other Notes:

Individual Bank Measurements

Total Inventoried Length	Bank Erosive Bank Lngth	Average Bank Slope Hgt	Strm Wdth	Strm Depth		Indv Rating	Recession Rank
2358.9	1735.6	2	2.6	0.1		1	2
						2	1.5
						3	1.5
						4	2
						5	2
						6	1
2358.9	1735.6	2	2.6	0.10		sec. total	10
			W/D Ratio		26	Recession Rate	0.27
Total Inventoried Length	Total Erosive Length						
2358.9	1735.6	2.00				Ave. Rec.Rank	10.00
						Ave. Rec.Rate	0.27

Listed From:	Headwaters to confluence with Fall Creek			
Total Inventoried Stream Length:		0.89	miles	4718 feet, 1438 meters
Extrapolated data to		2.91	miles	15,365 feet, 4683 meters
Listed Length:		4.57	miles	
Total Stream Length		4.57	miles	
Inventoried Stream Length is	19.47		% of Listed Length	
Extrapolated data to	63.68		% of Listed Length	

Camp Creek Streambank Erosion Inventory Page 1

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (ER)	10	tons/mile/year
Feet of Similar Stream Types	15365.00	feet
Eroding bank extrapolation	7089.56	feet
Total stream bank erosion	**31.9**	tons/year

Eroding Area	**Reach erosion rate**		**Eroding Area with Load Reductions**	**Reach erosion rt ld reduction**	
6942.4	84	tons/year	**1887.1**	4	tons/year
Recession Rate			Recession Rate		
0.27			0.05		
Bulk Density			Bulk Density		
90			90	**Total for seg's after reduction**	
	84	tons/year		4	tons/year/sample
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
6942	84	tons/year/sample		80	tons/year/sample
Recession Rate					
0.27					
Avg. Bulk Density					
90					

Camp Creek Streambank Erosion Inventory Page 2

Stream Bank Erosion Inventory Worksheet

Stream	Fall Creek	**Data reduced by**	Darcy Sharp
Section	Upper Fall Creek reach from Haskin Creek to Camp Creek		
Field Crew	Tom Herron DEQ; Sr. Water Quality Analyst		
	Melissa Thompson DEQ; Sr. Water Quality Analyst		
	Darcy Sharp, DEQ; Biologist		
Land Use	rangeland		

Stream Segment Location

			Degrees	Minutes	Elevation
GPS:	Upstream	N	43	21.108	5869
		W	111	29.411	
	Downstream	N	43	21.488	
		W	111	29.763	

Stream Bank Erosion Calculations

AVE. Bank Height:	2.4	feet	**Bank to bank length**	**6174**	feet
bank to bank Eroding Seg. Length	2214	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.36				
Bank erosion over sampled reach (E)	38	tons/year/sample reach			
Erosion Rate (ER)	65	tons/mile/year			
Feet of Similar Stream Type	7656	feet			
Eroding bank extrapolation	7704.89	feet			
Total stream bank erosion	**133**	tons/year			

Comments

Flow a contributing factor?: Yes

As flow increases, beaver dam breakage increases

Other contributing factors?: Direct hoof chiseling by cattle. Apparently significant grazing impact.

Upland sediment contribution from ephemeral gullies and old road-Forest Route now closed to motorized traffic.

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Strm Wdth	Strm Depth	Indv Rating	Recession Rank
3087	1107	2.4	4.5	0.2	1	2
					2	1.5
					3	1
					4	1.5
					5	1.5
					6	1
3087	1107	2.4	4.5	0.20	sec. total	8.5
			W/D Ratio	22.5	Recession Rate	0.16
Total Inventoried Length	Total Erosive Length					
3087	1107	2.40			Ave. Rec.Rank	8.5
					Ave. Rec.Rate	0.2

Listed From:	Headwaters to confluence with South Fork Fall Creek			
Total Inventoried Stream Length:		1.17	miles	6174 feet, 11812 meters
Extrapolated data to		1.45	miles	7656 feet, 2334 meters
Listed Length:		12.18	miles	
Total Stream Length		17.38	miles	
Inventoried Stream Length is	9.61		% of Listed Length	
Extrapolated data to	11.90		% of Listed Length	

Stream Bank Erosion Reduction Calculations		
Bank erosion over sampled reach (E)	7	tons/year/sample reach
Erosion Rate (ER)	11	tons/mile/year
Feet of Similar Stream Types	7656.00	feet
Eroding bank extrapolation	4297.20	feet
Total stream bank erosion	**23.2**	tons/year

Eroding Area	**Reach erosion rate**		**Eroding Area with Load Reductions**	**Reach erosion rate load reduction**	
5313.6	38	tons/year	2963.5	7	tons/year
Recession Rate			Recession Rate		
0.16			0.05		
Bulk Density			Bulk Density		
90			90	**Total for segments after reduction**	
	38	tons/year		7	tons/year/sample
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
5314	38	tons/year/sample		32	tons/year/sample
Recession Rate					
0.16					
Avg. Bulk Density					
90					

Stream Bank Erosion Inventory Worksheet

Stream	Fall Creek	**Data reduced by**	Darcy Sharp
Section	Lower Fall Creek Reach from Gibson Creek to Forest Route 066		
Field Crew	Tom Herron DEQ; Sr. Water Quality Analyst		
	Melissa Thompson DEQ; Sr. Water Quality Analyst		
	Darcy Sharp, DEQ; Biologist		
Land Use	grazing		

Stream Segment Location

			Degrees	Minutes	Elevation
GPS:	Upstream	N	43	22.231	5727
		W	111	29.758	
	Downstream	N	43	22.422	5707
		W	111	29.342	

Stream Bank Erosion Calculations

AVE. Bank Height:	1.9	feet	**Bank to bank length**	4302	feet
bank to bank Eroding Seg. Length	240	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.06				
Bank erosion over sampled reach (E)	1	tons/year/sample reach			
Erosion Rate (ER)	3	tons/mile/year			
Feet of Similar Stream Type	44880	feet			
Eroding bank extrapolation	5247.53	feet			
Total stream bank erosion	**27**	tons/year			

Comments

Flow a contributing factor?: Yes

Potential to blow out old beaver dams

Other contributing factors?: Two rip-rapped banks where meanders impinge on road (Forest Route 077).

Two culverts for bridges.

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Strm Wdth	Strm Depth		Indv Rating	Recession Rank
2151	120	1.9	4.5	0.2		1	1
						2	0.5
						3	0.5
						4	1
						5	1
						6	1
2151	120	1.9	4.5	0.20		sec. total	5
			W/D Ratio		22.5	Recession Rate	0.06
Total Inventoried Length	Total Erosive Length						
2151	120	1.90				Ave. Rec.Rank	5.0
						Ave. Rec.Rate	0.06

Listed From:	Headwaters to confluence with South Fork Fall Creek		
Total Inventoried Stream Length:	0.81	miles	4302 feet; 1311 meters
Listed Length:	8.5	miles	44,880 feet; 13,679 meters
Total Stream Length	12.18	miles	
Inventoried Stream Length is	17.38	miles	
Extrapolated data to	6.65	% of Listed Length	
	69.79	% of Listed Length	

Lower Fall Creek Streambank Erosion Inventory Page 1

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (ER)	9	tons/mile/year
Feet of Similar Stream Types	44880.00	feet
Eroding bank extrapolation	18812.40	feet
Total stream bank erosion	**80.4**	tons/year

Eroding Area	**Reach erosion rate**		**Eroding Area with Load Reductions**	**Reach erosion rt ld reduction**		
456	1	tons/year	1634.8	4	tons/year	
Recession Rate			Recession Rate			
0.06			0.05			
Bulk Density			Bulk Density			
90			90	**Total for seg's after reduction**		
	1	tons/year		4	tons/year/sample	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**		
456	1	tons/year/sample		-2	tons/year/sample	
Recession Rate						
0.06						
Avg. Bulk Density						
90						

Lower Fall Creek Streambank Erosion Inventory Page 2

Stream Bank Erosion Inventory Worksheet

Stream South Fork Fall Creek **Data reduced by** Darcy Sharp
Section 1.27 miles to fall creek road
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst
Melissa Thompson DEQ; Sr. Water Quality Analyst
Darcy Sharp, DEQ; Biologist
Land Use grazing

Stream Segment Location

			Degrees	Minutes	Elevation
GPS:	Upstream	N	43	21.108	5659
		W	111	29.411	
	Downstream	N	43	21.488	
		W	111	29.763	

Stream Bank Erosion Calculations

AVE. Bank Height:	1.8	feet	**Inv. bank to bank length**	4566	feet
bank to bank Eroding Seg. Length	564	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.12				
Bank erosion over sampled reach (E)	2	tons/year/sample reach			
Erosion Rate (ER)	4.2	tons/mile/year			
Feet of Similar Stream Type	16368	feet			
Eroding bank extrapolation	4607.61	feet			
Total stream bank erosion	**15**	tons/year			

Comments

Flow a contributing factor?: Yes
High flows will erode more tire track area
Other contributing factors?: Recreational motor vehicle tracks throughout lower 2/3 of inventory area
Water gaps are only on gravelly point bars since willow thickets are too strong for cattle to get down in soil areas.

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Strm Wdth	Strm Depth	Indv Rating	Recession Rank
2283	282	1.8			1	0.5
					2	0
					3	0
					4	1
					5	1
					6	1
2283	282	1.8			sec. total	3.5
			W/D Ratio		Recession Rate	0.04
Total Inventoried Length	Total Erosive Length					
2283	282	1.80			Ave. Rec.Rank	3.5
					Ave. Rec.Rate	0.04

Stream Length--unlisted stream

Inventoried Stream Length(both banks):	0.62	miles	3300 feet, 1006 meters
Extrapolated data to(both banks):	7.4	miles	39072 feet, 11909 meters
Listed Length:	0	miles	
Total Stream Length (both banks):	12.4	miles	
Inventoried Stream Length is	5.00	% of Stream Length	
Extrapolated data to	59.68	% of Stream Length	

South Fork Fall Creek Streambank Erosion Inventory Page 1

Stream Bank Erosion Reduction Calculations		
Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (ER)	9	tons/mile/year
Feet of Similar Stream Types	16368.00	feet
Eroding bank extrapolation	7460.40	feet
Total stream bank erosion	**30.2**	tons/year

Eroding Area	**Reach erosion rate**		**Eroding Area with Load Reductions**	**Reach erosion rt ld reduction**	
1015.2	2	tons/year	1643.8	4	tons/year
Recession Rate			Recession Rate		
0.04			0.05		
Bulk Density			Bulk Density		
90			90	**Total for segs after reduction**	
	2	tons/year		4	tons/year/sample
Eroding Area	Average Reach erosion rate			**Total Reduction**	
1015.2	2	tons/year/sample		-2	tons/year/sample
Recession Rate					
0.04					
Avg. Bulk Density					
90					

Lower Fall Creek Streambank Erosion Inventory Page 2

CAMP CREEK				
Bank Height (feet)	Bank Length (Meters) (erosive in bold)	Bank Length (Feet) (erosive in bold)	Accumulated Total Erosive Length	Accumulated Total Length (Feet)
0.8	6	19.7		19.7
2.8	**4**	**13.1**	13.1	32.8
1.3	**7**	**23.0**	23.0	55.8
2.2	**7**	**23.0**	23.0	78.7
1.7	**9**	**29.5**	29.5	108.3
0.8	2	6.6		114.8
4.5	6	19.7		134.5
0.8	5	16.4		150.9
3.8	**14**	**45.9**	45.9	196.9
3.5	**11**	**36.1**	36.1	232.9
1.4	3	9.8		242.8
4	**3**	**9.8**	9.8	252.6
2.9	6	19.7		272.3
2.2	**3**	**9.8**	9.8	282.2
1.4	**4**	**13.1**	13.1	295.3
1.8	10	32.8		328.1
1.5	**8**	**26.2**	26.2	354.3
3.2	**6**	**19.7**	19.7	374.0
1.6	**5**	**16.4**	16.4	390.4
1.5	6	19.7		410.1
3.2	**17**	**55.8**	55.8	465.9
2.5	5	16.4		482.3
5.5	**2**	**6.6**	6.6	488.8
1	5	16.4		505.2
1.7	**18**	**59.1**	59.1	564.3
2	3	9.8		574.1
3.1	**30**	**98.4**	98.4	672.6
0.5	2	6.6		679.1
2.7	**10**	**32.8**	32.8	711.9
3	**29**	**95.1**	95.1	807.1
1	2	6.6		813.6
2.4	**2**	**6.6**	6.6	820.2
1	4	13.1		833.3
2	4	13.1		846.5
2.5	**5**	**16.4**	16.4	862.9
2.2	8	26.2		889.1
1.5	5	16.4		905.5
1.6	**15**	**49.2**	49.2	954.7
0.5	1	3.3		958.0
0.5	**4**	**13.1**	13.1	971.1
1.5	4	13.1		984.3
3	**2**	**6.6**	6.6	990.8
1	3	9.8		1000.7
1.5	3	9.8		1010.5
1	8	26.2		1036.7
2.5	**22**	**72.2**	72.2	1108.9
1.2	4	13.1		1122.0
4	**5**	**16.4**	16.4	1138.5
1	5	16.4		1154.9
2.5	**12**	**39.4**	39.4	1194.2
1	3	9.8		1204.1
3.5	**16**	**52.5**	52.5	1256.6
0.7	1	3.3		1259.8
2	15	49.2		1309.1
2.5	2	6.6		1315.6
7	**18**	**59.1**	59.1	1374.7
0.5	5	16.4		1391.1
0.5	**3**	**9.8**	9.8	1400.9
2.2	**5**	**16.4**	16.4	1417.3
1.5	**7**	**23.0**	23.0	1440.3
1.1	5	16.4		1456.7
2	**3**	**9.8**	9.8	1466.5
1.5	**7**	**23.0**	23.0	1489.5
2.5	**7**	**23.0**	23.0	1512.5
1	**4**	**13.1**	13.1	1525.6
1	6	19.7		1545.3
1.5	**14**	**45.9**	45.9	1591.2
1.5	5	16.4		1607.6
1.5	**6**	**19.7**	19.7	1627.3
1	3	9.8		1637.1
0.7	**27**	**88.6**	88.6	1725.7
1	5	16.4		1742.1
1.5	**4**	**13.1**	13.1	1755.2
2	4	13.1	13.1	1768.4
3	**5**	**16.4**	16.4	1784.8
4.5	**7**	**23.0**	23.0	1807.7
2.5	**10**	**32.8**	32.8	1840.6
2	3	9.8		1043.3
2.5	**10**	**32.8**	32.8	1883.2
2	2	6.6		1889.8
1.2	**26**	**85.3**	85.3	1975.1
1.2	**13**	**42.7**	42.7	2017.7
2	4	13.1		2030.8
1.5	**40**	**131.2**	131.2	2162.1
2.5	6	19.7		2181.8
1.8	**16**	**52.5**	52.5	2234.3
1	**10**	**32.8**	32.8	2267.1
0.5	3	9.8		2276.9
2	12	39.4		2316.3
2	**13**	**42.7**	42.7	2358.9
2.0		2358.9	1735.6	

Streambank Erosion Inventory Raw Data Page 1

UPPER FALL CREEK				
Bank Height (feet)	Bank Length (paces) (erosive in bold)	Bank Length (Feet) (erosive in bold)	Accumulated Total Erosive Length	Accumulated Total Length (Feet)
2.3	18	54.0		54.0
1	8	24.0		78.0
4.5	**10**	**30.0**	30.0	108.0
1.4	5	15.0		123.0
1.2	13	39.0		162.0
3.9	**5**	**15.0**	15.0	177.0
1.7	34	102.0		279.0
3	6	18.0		297.0
0.4	15	45.0		342.0
2.7	5	15.0		357.0
0.5	3	9.0		366.0
2.2	17	51.0		417.0
5.5	**42**	**126.0**	126.0	543.0
1.5	22	66.0	6.0	609.0
4	**2**	**6.0**		615.0
1.6	16	48.0		663.0
0.5	26	78.0		741.0
1.6	10	30.0		771.0
0.5	3	9.0		780.0
0.5	38	114.0		894.0
1.7	10	30.0		924.0
1.8	**12**	**36.0**	36.0	960.0
1.3	12	36.0		996.0
3.5	23	69.0		1065.0
5.2	**24**	**72.0**	72.0	1137.0
1.8	**4**	**12.0**	12.0	1149.0
0.5	37	111.0		1260.0
4.5	**2**	**6.0**	6.0	1266.0
0.7	4	12.0		1278.0
2.4	**5**	**15.0**	15.0	1293.0
3	**24**	**72.0**	72.0	1365.0
1.2	11	33.0		1398.0
0.5	10	30.0		1428.0
4.8	**30**	**90.0**	90.0	1518.0
15	**68**	**204.0**	204.0	1722.0
5	**13**	**39.0**	39.0	1761.0
0.5	13	39.0		1800.0
1.2	30	90.0		1890.0
2	27	81.0		1971.0
1.2	21	63.0		2034.0
1.3	13	39.0		2073.0
0.5	42	126.0		2199.0
5.5	**78**	**234.0**	234.0	2433.0
0.5	25	75.0		2508.0
0.5	20	60.0		2568.0
4.5	**50**	**150.0**	150.0	2718.0
0.4	20	60.0		2778.0
0.2	15	45.0		2823.0
2	14	42.0		2865.0
2.4	38	114.0		2979.0
4	36	108.0		3087.0
2.4		3087.0	1107.0	

LOWER FALL CREEK				
Bank Height (feet)	Bank Length (paces) (erosive in bold)	Bank Length (Feet) (erosive in bold)	Accumulated Total Erosive Length	Accumulated Total Length (Feet)
0.5	10	30.0		30.0
2.5	42	126.0		156.0
2.5	20	60.0		216.0
1	58	174.0		390.0
2	17	51.0		441.0
4.5	**11**	**33.0**	33.0	474.0
0.7	25	75.0		549.0
3	**5**	**15.0**	15.0	564.0
0.7	28	84.0		648.0
2.5	27	81.0		729.0
3.5	**8**	**24.0**	24.0	753.0
0.5	33	99.0		852.0
0.7	48	144.0		996.0
1.5	27	81.0		1077.0
0.7	47	141.0		1218.0
6.5	**8**	**24.0**	24.0	1242.0
0.7	73	219.0		1461.0
0.7	61	183.0		1644.0
2	37	111.0		1755.0
0.5	24	72.0		1827.0
1	21	63.0		1890.0
0.5	5	15.0		1905.0
5	5	15.0		1920.0
1	15	45.0		1965.0
0.5	28	84.0		2049.0
6	**8**	**24.0**	24.0	2073.0
1	26	78.0		2151.0
1.9		2151.0	120.0	

SOUTH FORK FALL CREEK				
Bank Height (feet)	**Bank Length (paces)**	**Bank Length (Feet)**	**Accumulated Total Erosive Length**	**Accumulated Total Length**
	(erosive in bold)	**(erosive in bold)**		**(Feet)**
0.8	8	24.0		24.0
1.8	8	24.0		48.0
2.1	39	117.0		165.0
2.2	**29**	**87.0**	87.0	252.0
2	27	81.0		333.0
0.5	7	21.0		354.0
1.5	8	24.0		378.0
2	**6**	**18.0**	18.0	396.0
1.6	79	237.0		633.0
2.2	**10**	**30.0**	30.0	663.0
1.4	35	105.0		768.0
2	**4**	**12.0**	12.0	780.0
1.3	80	240.0		1020.0
2.3	**6**	**18.0**	18.0	1038.0
1.8	16	48.0		1086.0
2	**7**	**21.0**	21.0	1107.0
1	12	36.0		1143.0
0.8	16	48.0		1191.0
1	**5**	**15.0**	15.0	1206.0
1	6	18.0		1224.0
3.5	**3**	**9.0**	9.0	1233.0
1	14	42.0		1275.0
2	**3**	**9.0**	9.0	1284.0
1	18	54.0		1338.0
2	**3**	**9.0**	9.0	1347.0
0.5	5	15.0		1362.0
1.8	**14**	**42.0**	42.0	1404.0
0.5	11	33.0		1437.0
14	**1**	**3.0**	3.0	1440.0
0.5	22	66.0		1506.0
1.4	20	60.0		1566.0
2	**3**	**9.0**	9.0	1575.0
0.5	23	69.0		1644.0
1.7	41	123.0		1767.0
0.3	52	156.0		1923.0
0.5	120	360.0		2283.0
1.8		2283.0	282.0	

McNeil Sediment Core Results

McNeil Sediment Core Sampling Form						
Stream:	Fall Creek					
Date:	10/9/02					
Location:	Off Fall Creek Road					
Lat/Lon:	N: 43 deg 22.177'					
	W: -111 deg 29.790'					
Site Desc:	Meanders at unimproved camp site ~100 yd off Fall Crk Rd					
Personnel:	Darcy Sharp, Melissa Thompson					
Rosgen Channel:	C					
Reach Gradient:	0.30%					
Geology: (Q G V S)	V over S					
Target Species	CTT, BKT					
Sample Number		**1**	**2**	**3**		
Seive Size (inches)		ML	ML	ML		
2.5		0	250	480		
1		785	1620	790		
0.5		1250	2510	1325		
0.25		880	1960	1195		
1.0 - 0.25" Subtotal		2915	6090	3310		
#4		350	620	420		
#8		610	110	500		
#20		480	405	190		
#70		1065	1300	800		
#270		260	45	260		
<0.25" Subtotal		2765	2480	2170		
Sample Total						
W/O 2.5"		5680	8570	5480	Mean	Std. Dev.
% Fines W/O 2.5"		0.49	0.29	0.40	0.39	0.10
Sample Total						
W 2.5"		5680	8820	5960	Mean	Std. Dev.
% Fines W 2.5"		0.49	0.28	0.36	0.38	0.10

McNeil Sediment Core Sampling Form						
Stream:	South Fork Fall Creek					
Date:	10/29/02					
Location:	South Fork Fall Creek road crossing					
Lat/Long:	N: 43 deg 23' 34.3 "					
	W: -111 deg 26' 56.4"					
Site Desc:	20 yds S of fire ring in unimproved campground					
Personnel:	Darcy Sharp, Melissa Thompson					
Rosgen Channel:		C/D lower reach				
Reach Gradient:		1.00%				
Geology: (Q G V S)		V over S				
Target Species		Salmonid spawning				
Sample Number		1	2	3		
Seive Size (inches)		ML	ML	ML		
2.5		0	0	70		
1		1760	1800	890		
0.5		1920	2040	2600		
0.25		1240	1640	2100		
1.0 - 0.25" Subtotal		4920	5480	5590		
#4		395	460	570		
#8		860	1020	990		
#20		820	1430	1410		
#70		530	800	1170		
#270		90	105	150		
<0.25" Subtotal		2695	3815	4290		
Sample Total						
W/O 2.5"		7615	9295	9880	Mean	Std. Dev.
% Fines W/O 2.5"		0.35	0.41	0.43	0.40	0.04
Sample Total						
W 2.5"		7615	9295	9950	Mean	Std. Dev.
% Fines W 2.5"		0.35	0.41	0.43	0.40	0.04

Appendix C. Streambank Erosion Inventory Methods

Subsurface Fine Sediment Sampling

A McNeil sediment core sample was collected to describe size composition of bottom materials in salmonid spawning beds of the Fall Creek watershed. The McNeil sampling method was developed to determine the amount of fine sediment in spawning gravels for fish habitat studies in wadable streams (Bunte and Abt 2001). In order to determine support of salmonid spawning beneficial use, DEQ defines the term "fine" as particles less than 0.25 inches (6.3 mm) in diameter. These are the particles that would pass through a 0.25-inch mesh sieve. In common usage, these particles would be termed as silt, sand, or very small gravels.

Site Selection

Sites were selected in appropriate spawning habitat determined according to gravel size, depth, and velocity as identified by an experienced fisheries biologist (Tom Herron, DEQ 2002). The sites on Fall Creek and South Fork Fall Creek were both between two pools, just downstream of a pool tailout area. No spawning habitat was available on Camp Creek to be sampled because the substrate was 100% silt.

Field Methods

A cylinder 12 inches in diameter is worked into the substrate of a wadeable stream. Bucketsful of the bottom material are dug by hand to a depth of four to six inches into the substrate without breaking the seal of the cylinder with the stream's substrate. The sample is placed wet into a stack of sieves, and washed and shaken to divide the sample into particle size classes. Nine sieves are stacked in the size classes given in Table 12. Silt passing the finest sieve is discarded, since this size of material would be removed through the physical action of building a redd for spawning.

Metric	English
63 mm	2 ½ “
25 mm	1 “
12.5 mm	½ “
6.3 mm	¼ “
4.75 mm	0.187“ No. 4
2.36 mm	0.937” No. 8
850 µm	0.331” No. 20
212 µm	0.0083” No. 70
53 µm	0.0021” No. 270

Table 12. Particle size distribution of McNeil sediment core sample

The volume of solids retained by each sieve is measured via a water displacement method. The solids retained by each sieve is poured into a water-filled heavy metal bucket fashioned with a spigot near the top. A plastic bucket is placed under the spigot where displaced water pours out of the metal bucket. The volume of water in the plastic bucket is measured in a graduated cylinder to determine the volume of solids retained in that particular sieve size.

Data Analysis

The percent fines are computed for size distributions after subtracting the large particle sizes for 63 mm (2.5 inches) and greater. This is so that the percent fines are not affected by the presence of a few larger particles (Bunte and Abt 2001). If a large cobble were added to a sample, it could be 20% of the sample mass, and the percent fines would be smaller than if the large cobble were removed.

Three sediment core samples are collected and the particle sizes are analyzed in two groups:

- 6.3 mm and greater; and
- 4.75 mm to 0.53 mm.

The result for a site equals the volume of particles in the "4.75-0.53 mm" group expressed as a percentage of the total sample. Each of the three samples are averaged for an overall percentage of fine sediment for the site.

Streambank Erosion Inventory Methods

Field Methods

Streambank erosion inventory methods are based upon NRCS (1983) methods. The field crew is composed of two to three people trained as a group for consistency of measurement and evaluation. Stream reaches are measured for bank height and length. The reaches are identified as erosive or stable and evaluated for bank condition, vegetation, shape of the channel, effects of downcutting, and depositional status. According to these classifications, a cumulative rating is assigned to each homogenous reach. A lateral recession rate is assigned according to the cumulative ratings determined during the streambank erosion inventory. Table 13 shows the relationship of the cumulative rating with lateral recession rate.

Cumulative Rating	Recession Rate (feet per year)
0	.01
1	.02
2	.03
3	.04
4	.05
5	.06
6	.09
7	.12
8	.15
9	.16
10	.27
11	.38
12	.50
13	.61
14	.73
15	.84

Table 13. Recession ranking

Bank Erosion Calculations

The direct volume method is used to calculate average annual erosion rates for a given stream segment based on bank recession rate determined in the survey (NRCS 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor. The direct volume method is summarized in the following equations:

$E = [A_E * R_{LR} * \rho_B]/2000$ lbs/ton

where:
E = bank erosion over samples stream reach (tons/year/sample reach)
A_E = eroding area (ft^3)
R_{LR} = lateral recession rate (ft/yr)
ρ_B = bulk density of bank material (lbs/ft^3) = 90 is the default value

The bank erosion rate is calculated by dividing the sampled bank erosion by the total stream length sampled:

$E_R = E/L_{BB}$

where:
E_R = bank erosion rate (tons/mile/year)
E = bank erosion over sampled stream reach (tons/year/sample reach)
L_{BB} = bank to bank stream length over sampled reach

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold and others 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value is considered a long term average. For example, a 50-year flood event might cause five feet of bank erosion in one year and over a ten-year period this event accounts for the majority of bank erosion.

The *eroding area* (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. Pacing is used to measure horizontal distance, and bank slope heights are continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both.

Determining the *lateral recession rate* (R_{LR}) is one of the most critical factors in this methodology (NRCS 1983). To facilitate consistent data collection, the NRCS developed rating factors used to estimate lateral recession rate. The NRCS method measures bank and channel stability, and then uses the ratings as surrogates for bank erosion rates. The IDEQ developed recession rates using the NRCS methods, as given in Table 13.

Appendix D. Temperature Data

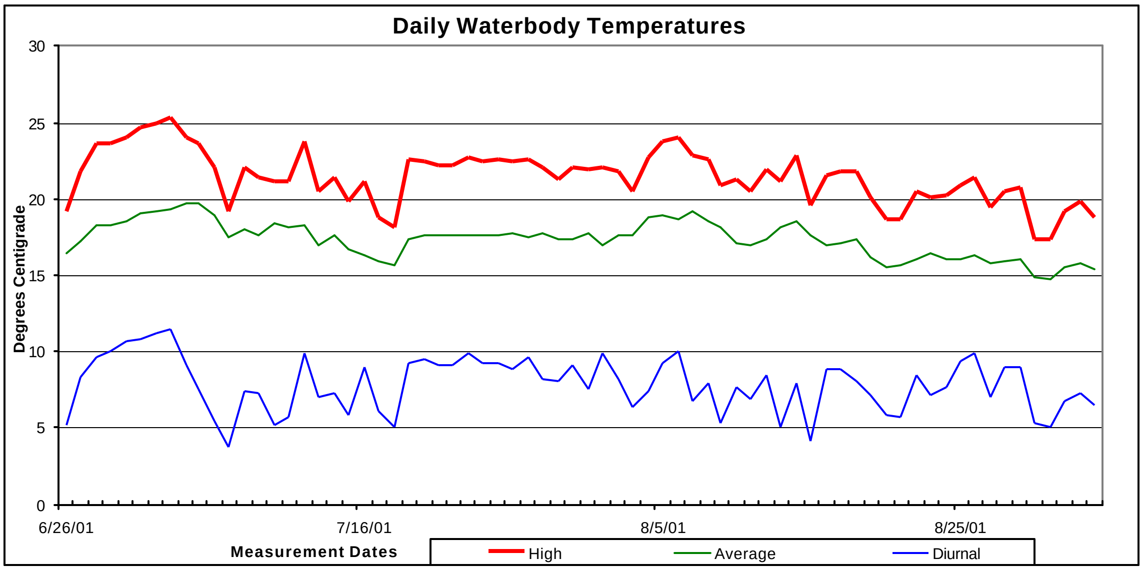
Fall Creek near Little Currant Creek 2001

DEQ Summary of Temperature Data

Data Source Name: Caribou-Targhee National Forest
Water Body Name: Fall Creek
Data Collection Site: fall01.dtf
Data Period: 6/26/2001 - 9/3/2001

MDMT = 25.3, 03 Jul
MWMT = 24.3, 05 Jul
MDAT = 19.7, 04 Jul
MWAT = 19.2, 06 Jul

HUC4 Number: 17040104
HUC4 Name: Palisades
South of the Salmon Clearwater Divide
Idaho Bull Trout Elevation: 1670 M
Waterbody ID Number: 43



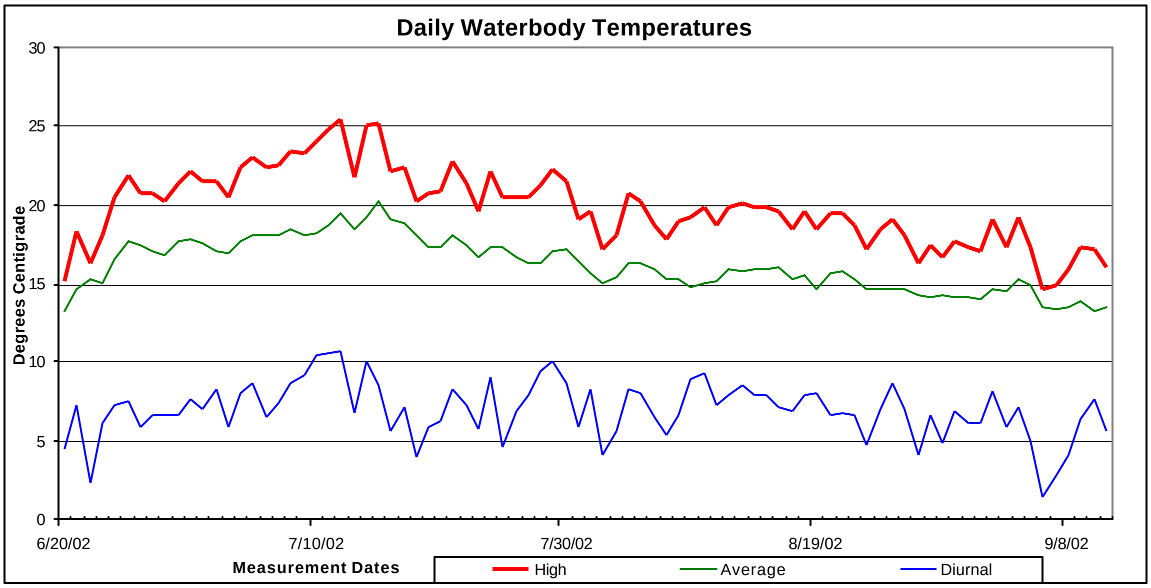
Fall Creek near Little Currant Creek 2002

DEQ Summary of Temperature Data

Data Source Name: Caribou-Targhee National Forest
Water Body Name: Fall Creek
Data Collection Site: fall02.dtf
Data Period: 6/20/2002 - 9/11/2002

MDMT = 25.5, 12 Jul
MWMT = 24.2, 15 Jul
MDAT = 20.3, 15 Jul
MWAT = 19.2, 16 Jul

HUC4 Number: 17040104
HUC4 Name: Palisades
South of the Salmon Clearwater Divide
Idaho Bull Trout Elevation: 1670 M
Waterbody ID Number:



Solar Pathfinder data for ten stations on Fall Creek

Percent of Daily Total Radiation Exposed

Month/Site	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Average
May	0.94	0.62	0.81	0.55	0.95	0.83	0.76	0.78	0.61	0.46	0.731
June	0.97	0.62	0.78	0.66	0.98	0.84	0.82	0.78	0.65	0.52	0.762
July	0.95	0.62	0.78	0.61	0.95	0.84	0.81	0.78	0.61	0.46	0.741
August	0.94	0.48	0.79	0.56	0.92	0.78	0.63	0.8	0.63	0.52	0.705
Sept	0.92	0.38	0.8	0.51	0.32	0.76	0.6	0.8	0.66	0.38	0.613
										mean	0.7104

Percent of Daily Total Radiation Blocked

Month/Site	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Average
May	0.06	0.38	0.19	0.45	0.05	0.17	0.24	0.22	0.39	0.54	0.269
June	0.03	0.38	0.22	0.34	0.02	0.16	0.18	0.22	0.35	0.48	0.238
July	0.05	0.38	0.22	0.39	0.05	0.16	0.19	0.22	0.39	0.54	0.259
August	0.06	0.52	0.21	0.44	0.08	0.22	0.37	0.2	0.37	0.48	0.295
Sept	0.08	0.62	0.2	0.49	0.68	0.24	0.4	0.2	0.34	0.62	0.387
										mean	0.2896

Average Solar Radiation (kWh/m2/day)

Month/Site	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Average
May	5.828	3.844	5.022	3.41	5.89	5.146	4.712	4.836	3.782	2.852	4.5322
June	6.79	4.34	5.46	4.62	6.86	5.88	5.74	5.46	4.55	3.64	5.334
July	6.935	4.526	5.694	4.453	6.935	6.132	5.913	5.694	4.453	3.358	5.4093
August	5.922	3.024	4.977	3.528	5.796	4.914	3.969	5.04	3.969	3.276	4.4415
Sept	4.6	1.9	4	2.55	1.6	3.8	3	4	3.3	1.9	3.065
										mean	4.5564

Excerpt from Appendix E of Lower Sucker Creek, Illinois River Subbasin, TMDL and Water Quality Management Plan, April 2002, Oregon Department of Environmental Quality

The Physics of Stream Temperature

Stream temperature is driven by the interaction of many variables. Energy exchange may involve solar radiation, longwave radiation, evaporative heat transfer, convective heat transfer, conduction, and advection (Lee,1980; Beschta 1984). With the exception of solar radiation, which only delivers heat energy, these processes are capable of both introducing and removing heat from a stream. While interaction of these variables is complex, certain of them are more important than others (when assessing what is influencing stream temperature) (Beschta, 1987). Solar radiation is the singularly most important radiant energy source for the heating of streams during daytime conditions (Brown, 1984; Beschta, 1997). For a stream with a given surface area and stream flow, any increase in the amount of heat entering a stream from solar radiation will have a proportional increase in stream temperature (Brown, 1972). Stream temperature is an expression of heat energy per unit volume, which in turn is an indication of the rate of heat exchange between a stream and its environment

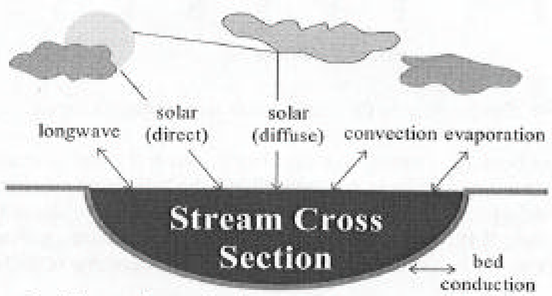


Figure 3. Thermodynamic (heat transfer) processes that heat or cool water.

When a stream surface is exposed to solar radiation, quantities of heat will be delivered to the stream system (Brown 1969, Beschta et al. 1987). Some of the incoming solar radiation will reflect off the stream surface, depending on the elevation of the sun. All solar radiation outside the visible spectrum (0.36μ to 0.76μ) is absorbed in the first meter below the stream surface and only visible light penetrates to greater depths (Wunderlich, 1972). Sellers (1965) reported that 50% of solar energy passing through the stream surface is absorbed in the first 10 cm of the water column. Removal of riparian vegetation, and the shade it provides, contributes to elevated stream temperatures (Rishel et al., 1982; Brown, 1983; Beschta et al., 1987). Exposure to direct solar radiation will often cause a dramatic increase in stream temperatures. When shaded throughout the entire day, far less heat energy will be transferred to the stream. The ability of riparian vegetation to shade the stream depends on vegetation height, density, stream width and position relative to the stream. Decreased shade levels result from a lack of adequate riparian vegetation to reduce sunlight reaching the stream surface (e.g. heat from incoming solar radiation).

Models have been developed based on a heat budget approach which estimate water temperature under different heat balance and flow conditions. Using mathematical relationships to describe heat transfer processes, the rate of change in water temperature on a summer day can be estimated.

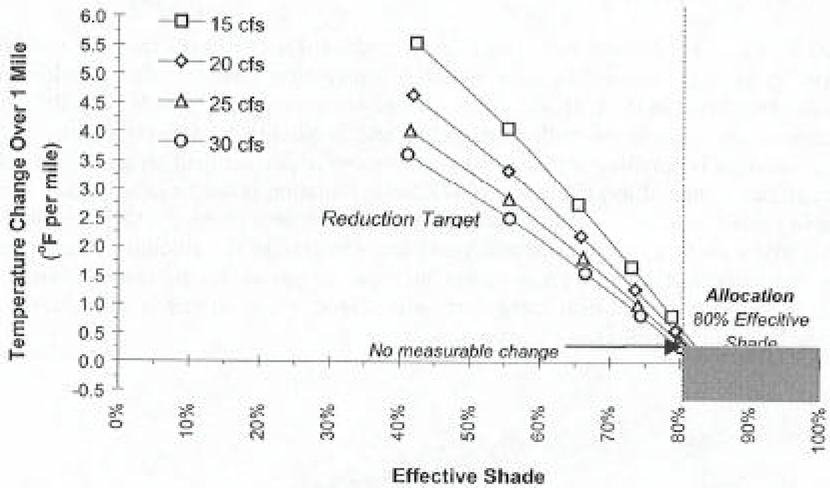


Figure 4. Stream shade, flow and water temperature change.

Figure 4 shows the relationship between stream flow and heating over 1 mile of stream for various shade values. As the shade values increase, a point is reached where the reduction in stream temperature may not be measurable. In the modeled values in Figure 4 (Boyd, 1999), at 80% shade there is little gain in stream temperature reduction for all flow values. This suggests that 80% stream shade is a threshold for optimum shading even though some benefit is gained in stream temperature reduction for higher shade values.

As channel width increases, a point is reached where mature conifers are not tall enough to totally shade the channel and optimum shade values may be less than 80%. Assuming a site potential tree is 150 feet tall, as channel width increases over 30 feet, shade decreases. As shown in figure 5, at stream widths above 40 feet, the optimum shade values fall below 80%. In channels wider than 30 feet, channel shape plays an important role in stream heating. If excessive sediment has deposited in the channel causing the channel to widen, there is more stream surface area exposed to heat transfer from solar radiation, and the result is increases in stream temperature. This is the case on the main stem of Sucker Creek (see channel discussion).

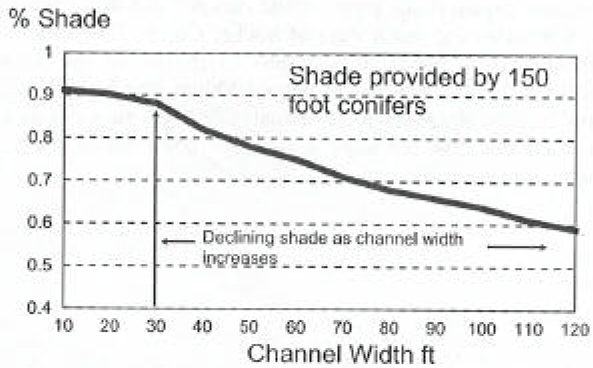


Figure 5. Shade decreases and channel width increases.

Existing Shade and Potential Shade

Existing shade is simply a measure of the amount of shade provided by the existing vegetation to the stream. This may or may not be the "total potential shade" or the most shade possible given the channel characteristics (stream width) and sites ability to grow trees. Existing shade is a measure of the current condition. Site potential shade is the optimum shade that can be expected given the channel and site characteristics.

In theory, it is possible to reach 100% stream shade. However, small amounts of sunlight will penetrate the most densely stocked (>70% effective shade density) trees. So in reality, the upper limit of potential stream shade is not 100% but between 95 to 97%. Tributaries to the main stem of Sucker and Grayback Creek are considered small streams and are capable of reaching 90% plus shade. As a stream gets wider, at some point even the tallest of mature trees can't shade the entire channel width (figure 5). This is the case on the main stem of Sucker Creek. Unlike the tributaries, the main stem under the best of conditions can only reach a potential shade value of 55% to 60%.

Appendix E. Distribution List

Caribou-Targhee National Forest
1405 Hollipark Drive
Idaho Falls, ID 83401

Copies available at:
Idaho Falls Public Library
DEQ, Idaho Falls Regional Office
DEQ, Internet website: http://www.deq.state.id.us/

Appendix F. Public Comments

Public comment period: April 21, 2003 to May 20, 2003. A public meeting was conducted on April 30, 2003.

No formal comments received from stakeholders, WAGs, agencies, or the general public. The public meeting had no attendees.